9:45 p. m. The barograph trace shows that after noon the pressure gradually fell from 28.82 inches to 28.67. Just about the time of the greatest severity of the storm the barograph pen dropped with great rapidity to 28.25, returning immediately and rising to 28.80, then dropping back quickly to 28.70, after which there was a slight fall until about 5 a. m. the next day. Two reliable gentlemen living near the residence of Hon. W. D. Washburn, which was near the center of the wide path of greatest damage, were watching an aneroid barometer at the time of the storm, and they state that the needle went down to 23 inches and returned almost immediately to near its former reading. This aneroid had been compared at this station not very long before the storm and found correct. Even allowing considerable for error because of a possible momentum gained by the needle, the reading was a remarkably low one.

The humidity at the 8 p. m. observation was 80 per cent; late in the afternoon, and early in the evening a number of persons made remarks about the "close" or "sultry" condition of the air.

The storm entered Minneapolis in the vicinity of Lake Calhoun, and from there it passed rapidly northeastward across the southern and south-central portions of the city to beyond the Mississippi River near Tenth avenue south. In nearly all the region mentioned very great damage was done to plate glass, chimneys, roofs, church steeples, telephone and telegraph poles and wires, and to thousands of very valuable shade trees. The Northwestern Telephone Company had over 7000 telephones rendered useless by the storm, and their poles and wires were in such condition that more than a week elapsed before all their telephones were in working order again.

While the barometer readings show undoubted evidence of the close proximity of a tornado funnel, the damage done shows, with a few exceptions, the effect of a straight blow of hurricane force. The trees, roofs, chimneys, steeples, and poles were thrown in nearly all cases toward the east or northeast, and it is probable that the damage occurred at the time of the shift of the wind just after the passage of the elevated tornado funnel. A few trees indicate by the different directions in which their branches were blown something of the effect of a whirl, but there was none of the rending, tearing, complete destruction, and utter confusion in the city such as accompanies the touching of the tornado funnel to the earth. It is possible that in at least two of the high buildings there was something of the explosive effect of the true tornado, as in the Guaranty Building and in Donaldson's Glass Block the large skylights seem to have been lifted sufficiently by an upward rush of air to raise the heavy glass from its fastenings, after which it fell back through the light wells to the floors below; very little, if any, of this glass was carried sideways by the force of the gale. Some of the plate glass, too, fell on the outsides of the buildings.

It is probably safe to say that the amount of damage by the storm in this city aggregated over $500,000, not counting the damage to the trees, which can not be estimated in money.

The severity of the storm was not the same in all parts of the storm-stricken region, but it would be impossible to say that there were any well-defined paths of destruction.

A telegraph operator was killed by lightning while at work in a part of the city not in the affected portion, but there were no deaths due to the storm, though a number were injured, and many had narrow escapes.

Carefully compiled newspaper reports indicate that the storm was first felt in northeastern South Dakota, in the vicinity of Aberdeen, shortly after 6 p. m., and that it moved eastward parallel with the line of the Hastings and Dakota Division of the Chicago, Milwaukee, and St. Paul Railway, and a short distance north of it. No serious damage seems to have been done in Minnesota until the storm reached Renville County, but from Renville County eastward through McLeod, Carver, Hennepin, Ramsey, and Washington counties, and thence into Wisconsin great damage occurred.

In McLeod County the path of destruction extended all the way across the county from west to east, with an area of 10 miles long by 1 mile wide, in which almost everything was entirely destroyed, including residences, farm buildings, stacked and shocked grain, trees, standing crops, and some cattle and horses, with a loss of 4 lives at or near Glencoe.

In Carver County, the greatest destruction was at Waconia, where the storm struck and destroyed the entire center of the village, killing 4 persons. At this point the fury of the storm resembled that of a tornado more than at any point east of McLeod County. The destruction extended east and west of Waconia about four miles in each direction. In Hennepin County, outside of Minneapolis, there was very great damage to residences, stores, and large manufacturing establishments in the towns of St. Louis Park and Hopkins, with 3 deaths in St. Louis Park; at Excelsior, on the south side of Lake Minnetonka, the loss was considerable, and there was a great deal of damage to the very fine properties on the north shore of Lake Minnetonka.

In Washington County, there was loss by the breaking up of large log rafts in St. Croix River, and to the extensive lumbering and other industries in and about Stillwater.

There were many exhibitions of the wonderful force of the wind, and many very strange and curious things were done by it.

Fifteen deaths were reported in Minnesota, 2 in South Dakota, and 1 in Wisconsin.

THE ORIGIN OF THE CUBA CYCLONES OF JUNE 13-14, 1904.

By MAXWELL HALL, dated Jamaica, August, 1904.[1]

On June 10 the barometric pressure over Jamaica was a little below the mean; on the 11th there was a further slight fall, so that the barometric pressure was about 0.1 inch below the mean that day. On the 12th and the morning of the 13th the pressure continued to give way, and at the Kempshot Observatory near Montego Bay the lowest was 0.3 inch below the mean at 7 a. m. on the 13th.

Up to the evening of the 12th this fall was due to a stationary cyclone or cyclonic depression, whose center was 20 miles west of the Negril Point Light-house. That evening the center began to move slowly toward the northeast, and then another center appeared early in the morning of the 13th about forty miles to the southwest of the light-house.

The first center we shall call *A*, and the second *B*.

A passed the light-house between 3 and 4 a. m., local time, June 13, and at 5 a. m. the wind veered to the south as *A* proceeded on its course, but, as *B* approached, the wind backed to southeast again; then it veered to south-southeast; the center *B* passed at about 8:30 a. m., and the wind continued to veer to south and southwest.

It may here be noted that the direction and force of the wind at any place under the influence of two centers are the resultants of the direction and force due to each center. Thus at 5 a. m. the wind at the light-house due to *A* would have been southwest; that due to *B*, southeast, with a resulting direction south.

A 6 a. m. the center *A* was near Kempshot, and it moved away in the direction of Santiago de Cuba at the rate of about fourteen miles an hour.

The cyclone *B* took a northerly course as far as Moron in

[1] A preliminary note on this subject appeared in the Monthly Weather Review for June, p. 273, under the heading "Cyclonic Depression and Flood in Jamaica." Later advices, showing that there were two separate depressions, necessitate a modification of the previous statement that the center took a curved path around the west end of the island.—ED.

Cuba, and then proceeded northeast. Off the Negril Point its rate of motion was about the same as that of A.

The fall of the barometer at the center of A was about 0.8 inch on the 12th and morning of the 13th, but the fall increased, the cyclone developed, and Santiago de Cuba and Guantanamo suffered from a great and destructive hurricane.

The fall of the barometer at the center of B was about 0.6 inch in the morning of the 13th.

The following tables give the reduced observations made at the light-house, at the Kempshot Observatory, and at Kingston.

Table 1.—*Observations made at the Negril Point Light-house by Mr. J. S. Brownhill.*

Date.	Time of observation.	Barometric pressure.	Wind. Direction, and velocity in miles per hour.	Wind. Miles in 24 hours.	Notes.
1904.		*Inches.*			
June 8	7:00 a. m.	29.906	ese. 4	365	
8	3:00 p. m.	29.907	ese. 10	....	
9	7:00 a. m.	29.918	ese. 20	460	
9	3:00 p. m.	29.862	se. 30	....	
10	7:00 a. m.	29.849	ese. 30	404	
10	3:00 p. m.	29.836	se. 12	....	
11	7:00 a. m.	29.840	se. 20	580	
11	3:00 p. m.	29.833	se. 30	....	
12	7:00 a. m.	29.795	se. 40	1,005	
12	3:00 p. m.	29.756	se. 40	....	
13	5:45 a. m.	29.710	se. 60	....	10 nimbus southeast.
13	6:15 a. m.	29.712	se. 60	....	Do.
13	6:30 a. m.	29.714	sse. 60	....	Do.
13	7:00 a. m.	29.712	s. 60	690	Do.
13	8:15 a. m.	29.718	ssw. 60	....	Do.
13	8:45 a. m.	29.709	sw. 60	....	10 nimbus south.
13	9:00 a. m.	29.723	sw. 60	....	Do.
13	9:30 a. m.	29.737	sw. 60	....	10 nimbus southwest.
13	10:00 a. m.	29.751	sw. 60	....	Do.
13	11:00 a. m.	29.753	sw. 40	....	Do.
13	11:30 a. m.	29.758	ssw. 40	....	10 cumulo-nimbus southwest.
13	Noon	29.762	ssw. 40	....	Do.
13	12:30 p. m.	29.768	ssw. 40	....	Clear; patches to be seen at intervals.
13	3:00 p. m.	29.754	ssw. 40	....	
14	7:00 a. m.	29.834	s. 30	510	

The barometer is reduced to all the standards and corrected for diurnal variation. The mean barometer was taken to be 29.932. The hour is given in local time. The anemometer is read at 7 a. m. each morning.

The gale was at its height between 3 and 4 a. m. on the 13th, when the puffs of wind must have been from 65 to 75 miles per hour. At 1 a. m. the wind was southeast; at 2, 3, and 4 a. m., south-southeast; and at 5 a. m., south.

Table 2.—*Observation made at the Kempshot Observatory by Mr. Maxwell Hall.*

Date.	Time of observation.	Barometric pressure.	Wind. Direction, and velocity in miles per hour.	Wind. Miles in 24 hours.	Rainfall.	Notes.
1904.		*Inches.*			*Inch.*	
June 8	7 a. m.	29.886	e. 5	....	......	As per Negril.
8	3 p. m.	29.891	ne. 3	....	......	
9	7 a. m.	29.940	e. 5	190	1.12	
9	3 p. m.	29.891	se. 7	....	......	Raining all day.
10	7 a. m.	29.857	e. 6	273	0.83	
10	3 p. m.	29.881	se. 4	....	......	Gusts up to 38 miles an hour.
11	7 a. m.	29.829	sse. 7	221	1.22	Cyclonic appearance of weather.
11	3 p. m.	29.831	sse. 6	....	......	
12	7 a. m.	29.791	sse. 15	266	0.00	
12	3 p. m.	29.846	sse. 15	....	......	Gusts up to 39 miles an hour.
12	7 p. m.	29.781	s. 25	....	......	
13	5 a. m.	29.657	s. 50	....	......	Rain during night; heavy squalls, with rain.
13	7 a. m.	29.634	s. 60	478	0.43	Gusts up to 70 miles.
13	9 a. m.	29.709	ssw. 60	....	......	Heavy rain.
13	11 a. m.	29.724	sw. 20	....	......	Heavy rain.
13	1 p. m.	29.757	sw. 20	....	......	Clouds lifting.
13	3 p. m.	29.776	sw. 15	....	......	Squalls at times.
13	5 p. m.	29.768	sw. 15	....	......	Clearing.
13	7 p. m.	29.764	sw. 10	....	......	
14	7 a. m.	29.825	ssw. 5	422	5.20	

The former notes as to time, reduction, etc., are of course applicable to Kingston. On the 12th, Sunday, the observations were made at Vale Royal, near Kingston.

Table 3.—*Observations made at Kingston by Mr. J. R. Scotland.*

Date.	Time of observation.	Barometric pressure.	Wind, in miles per hour.	Notes.
1904.		*Inches.*		
June 8....	9 a. m.	29.898	se. 14	5 alto-cumulus southwest. 5 strato-cumulus southeast.
8....	3 p. m.	29.919	se. 18	7 cirro-stratus. 2 strato-cumulus southeast.
9....	9 a. m.	29.911	se. 7	8 alto-stratus west-southwest. 2 strato-cirrus southeast.
9....	3 p. m.	29.877	se. 5	6 alto-cumulus southwest. 3 strato-cumulus southeast.
10....	9 a. m.	29.843	se. 10	1 alto-cumulus southwest. 2 strato-cumulus southeast.
10....	3 p. m.	29.884	se. 5	8 nimbus southeast; heavy rain day and night.
11...	9 a. m.	29.840	0	3 alto-stratus. 7 strato-cumulus southeast.
11....	3 p. m.	29.824	se. 5	8 alto-stratus west-southwest. 2 strato-cumulus southeast.
12....	7 a. m.	29.815	se. 8	8 strato-cumulus southeast.
12....	3 p. m.	29.801	se. 18	7 strato-cumulus southeast.
13....	9 a. m.	29.791	se. 7	8 nimbus southeast; rainy.
13....	11 a. m.	29.774	se. 10	3 alto-cumulus west. 5 strato-cumulus southeast.
13....	1 p. m.	29.800	se. 15	3 alto-cumulus west. 4 strato-cumulus southeast.
13....	3 p. m.	29.799	se. 18	9 nimbus southeast; rainy.
14....	9 a. m.	29.822	se. 8	6 cirro-stratus west. 2 strato-cumulus southeast.
14....	3 p. m.	29.825	se. 14	4 strato-cumulus southeast; clearing.

Fig. 1 shows the position of the centers at 6 a. m. on the 13th. Great accuracy is out of the question, but it will be found that the fall of pressure at Negril is the sum of the falls due to A and B, and that the direction of the wind is the resultant of the winds due to each center, and this is also true for Kempshot.

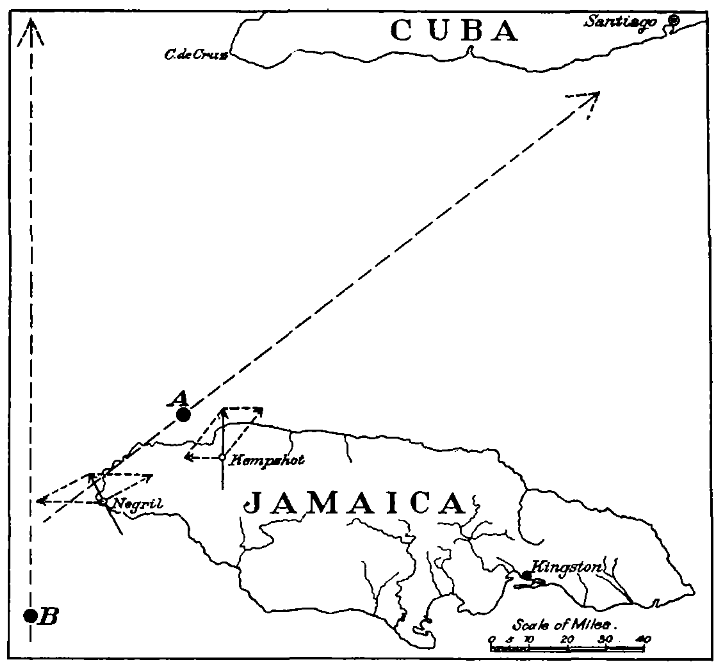

Fig. 1.—Positions of centers at 6 a. m., local time.

Kingston was rather too far from the centers to give us much information, and no reading was taken before 9 a. m. The lowest reading was at 11 a. m., which may show that the velocity of A as given above was somewhat too large, in accordance with the news that the worst of the cyclone at Santiago occurred at night, and not in the early evening.

Returning to Jamaica: a gale from the south swept the west end of the island and did some damage to shipping and to banana trees, but the rest of the island experienced only high winds and heavy rains.

There had been heavy rains on the 10th and 11th over the greater part of the island, so that when 6 or 8 inches fell over the western end of the island in a few hours in the morning of the 13th, low-lying towns were flooded, the rivers came down in flood and destroyed the banana trees planted along their banks, and carried away several bridges. Among the latter was the Barnet Bridge at Montego Bay; 3 out of the 5 mason-work arches were carried away, and the river, which rose 20 feet above its usual level, took a short cut from the railway bridge through the railway station to the sea.

Cane Valley, near the center of the island, suffered again, but not to the extent it did in June, 1886, when the water rose 60 to 100 feet. The flood rains that year were much heavier than the rains we are now considering, but they were both due to the same cause; namely, a barometric depression.

The barometer falls slightly over a very large area, much rain falls, a definite center is formed, and the whole phenomenon may, or may not, develop into a great cyclone.

The two depressions of June 13, 1904, certainly developed into cyclones, but nothing more was heard of the depression of June 7 and 8, 1886.

RECENT CONTRIBUTIONS TO CLIMATOLOGY.

By C. F. TALMAN, U. S. Weather Bureau.

Observational work in meteorology may be said to correspond to field work in the biological sciences, and has led up to corresponding conditions in recent years. The biologist of to-day finds himself confronted with an enormous mass of taxonomic material, which he has lately set himself seriously to the task of digesting and summarizing, so that it may form the basis of philosophical research. In a like manner the meteorologist has now observed the weather for longer or shorter periods over a great part of the earth's surface, but has only recently devoted much attention to the highly important work of computing means of the various series, in order to establish normal values for the climate of each meteorological station and group of stations.

The delay in reaching this stage in climatological investigation was in a measure justified by the fact that the extra-tropical regions, in which the majority of long weather records exist, are just those in which the weather variability from year to year is greatest, and in which, therefore, very long records are needed before satisfactory normals can be deduced. For example, it is estimated that the normal monthly temperature of Vienna for the winter months will not be known to within 0.1° C. of accuracy until four hundred years of recorded observations shall be available for discussion; while in western Siberia observations for eight hundred years will be needed.[1] When we come to consider the prospect of obtaining accurate decadal, pentadal, or daily normals, the extent of the record required seems to relegate the whole subject to our remote posterity. It should be remembered, however, that practical climatology does not, for all purposes, require minute exactitude in its numerical results; the determination of a monthly normal temperature to within one or two degrees of accuracy is exceedingly serviceable, while even the rough results obtained from two or three years of observations are vastly better than nothing. This fact has found recognition, and climatologists have recently been quite industrious in giving us mean values based on short records.

The immediate occasion of the present paper is the appearance, during the current year, of two very notable contributions to the quantitative climatology of extensive regions of the earth. These are:

Klimatographie von Österreich. I.—Klimatographie von Niederösterreich, von J. Hann. Wien, 1904.

Indian Meteorological Memoirs, Vol. XVII. I.—Normal monthly and annual means of temperatures, wind, humidity, cloud, rainfall, and number of rainy days of stations in India, etc. Calcutta, 1904.

The former of these works, which is published under the direction of the Austrian Zentralanstalt, inaugurates a series of sectional climatographies, sixteen in number, which when complete will cover the whole of Austria. Coming from the pen of the most eminent of living climatologists, this memoir may be considered the embodiment of the best and most modern climatological ideas. In fact, Doctor Pernter, the Director of the Zentralanstalt, in his introduction to the series pays a tribute to his distinguished predecessor and teacher, Doctor Hann, to whom, he says the preparation of the initial monograph was entrusted, in order that the authors of the subsequent parts might have for their guidance a perfect model for form and method.

Given a series of meteorological observations which it is desired to discuss fully in the form of tabulated averages, the number of tables required in order to bring out every feature of the climate deducible from the original figures is very large. This fact is well illustrated by the work now under consideration. Taking the temperature tables alone, we have, for certain stations: Mean variability of the daily mean temperature (for each month and for the year); mean frequency of daily temperature changes of given magnitudes (comparing the mean of each day with the mean of the next); departure from normal mean temperature for the coldest and warmest winters, and for the coldest and warmest summers, during one hundred and twenty-five years; extreme monthly and annual mean temperatures for fifty years; mean monthly, seasonal, and annual temperatures at various altitudes; probability that the yearly minimum will fall below 0°, —5°, —10°, —20°, etc.; average dates on which, in the annual march, the daily temperature rises above and falls below 5°, 10°, and 15°; duration, in days, of a daily temperature of 5°, 10°, and 15°; mean difference between the 2 p. m. and 7 a. m. temperatures for each month and for the year; besides the values regularly found in climatological summaries, such as the monthly and annual means, the means of the monthly and annual extremes, and the absolute extremes.

In the discussion of the other elements, the following are some of the tables introduced: Fluctuation of the yearly totals of rainfall for twenty years (the value for each year expressed as a percentage of the 20-year mean); distribution of the annual rainfall among the months (per cent); mean duration of rainless and rainy periods for each month and for the year; mean number of days on which the wind velocity reaches 6 (decimal scale) for each season and the year; influence of the wind direction upon the several meteorological elements.

It will be seen that a number of climatic features are here brought out which are commonly neglected in climatological discussions; but, far from exhausting the possibilities in this direction, Doctor Hann's memoir only opens up new vistas to the climatologist. It is probable, however, that nearly all aspects of the climate of Lower Austria which are of practical interest and for which materials were available are here presented. There is no discussion of pressure, because, as the author says, "the differences thereof over the relatively small surface of a country like Lower Austria have no climatological importance." Phenological figures also are omitted because of the lack of trustworthy observations.

The arrangement of this work presents some very excellent features. The area under discussion is divided into a few climatic regions, which are discussed separately. The stations in a single region are considered together in connection with each climatic feature; then a compact climatic table is given for each station. Finally, at the end of the volume the more important climatic values are more fully presented in general tables, convenient for reference.

Turning now to the latest of the Indian Meteorological Memoirs, we are confronted with a work of truly imposing proportions, the plan of which presents many contrasts to that of the Austrian memoir we have just been considering. While

[1] Hann: Handbuch der Klimatologie. I Bd. Pp. 11-12.